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HOW OPTEMPO, CREW TURNOVER, AND MATERIAL CONDITION AFFECT THE TRAINING READINESS OF SURFACE COMBATANTS

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ABSTRACT

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INTRODUCTION

A primary objective of the fleet is to have ships deploy with the highest degree of training readiness. Training readiness is difficult to measure, however, partly because peacetime activities of surface combatants do not regularly test the crew's readiness to undertake wartime missions. There have been attempts to measure the training readiness of ships by examining performance on periodic exercises or inspections that should reflect how well the crew has been trained. Results from several of those efforts are reviewed below.

A number of analyses have been conducted in recent years that relate ship operating tempo (OPTEMPO) to various objective and subjective measures of readiness and performance. The specific results of these efforts have varied because the analyses have used different samples of ships and different measures of effectiveness, and evaluated readiness over different time periods. Although these studies have consistently found that more OPTEMPO is related to increased readiness, this result was not always strong in magnitude or statistical significance.

Analysis presented in [1] evaluated the success rates of ships responding to threat presentations in battle group exercises. The data were developed from reconstruction of major battle group exercises and focused on ASW and ASUW threats. Although results were generally statistically insignificant, there was evidence that the percent of time spent underway in the year before the exercise was positively related to the probability of success in ASW detections and prosecutions for Atlantic Fleet ships.

Analysis presented in [2] examined crew performance in exercises conducted during Atlantic Fleet refresher training. The study concluded that the percent of time spent underway in the quarter before refresher training had a positive and statistically significant effect on exercise scores in the AAW and ASW mission areas. The level of manning of senior billets was also positively related to exercise performance, whereas crew turnover rates had a negative effect.

An alternative, although somewhat subjective, measure of ship readiness is performance in the Battle-E and mission area excellence competitions. Reference [3] reports that both the probability of winning the Battle-E and the probability of winning a mission area award were positively related to OPTEMPO. The probability of winning generally peaked at about 40 days OPTEMPO per quarter and there was some evidence that it declined for very high levels of operations.

Another approach to measuring readiness uses the regular information provided by official readiness statistics. The official system for reporting the readiness of military units is the Status of Resources and Training System (SORTS). SORTS evaluates unit status in specific mission areas and in four resource areas: personnel, equipment/supplies on hand, equipment status, and

training. Measures of unit readiness (C-ratings) in each of the four resource areas are on a five-point scale, as defined below:

- *C1*—Unit is trained to undertake the full wartime mission for which it is organized and designed.
- *C2*—Unit has accomplished the training necessary to undertake the bulk of the wartime mission for which it is organized and designed.
- *C3*—Unit has accomplished the training necessary to undertake major portions of the wartime mission for which it is organized and designed.
- *C4*—Unit requires additional training in order to undertake its wartime mission, but if the situation dictates, the unit may be directed to undertake portions of its wartime missions using the resources on hand.
- *C5*—Unit is undergoing a service-directed resource change and is not prepared at this time to undertake the wartime mission for which it is organized or designed.

There are limitations to all available measures of training readiness. For SORTS,[1] the key element in the measure is a count of the number of required exercises successfully completed. Although exercise completion is not linked directly to specific performance criteria, it does reflect an educated assessment by experienced naval officers of the minimum amount of training necessary to be prepared for a deployment.

Reference [4] contains analyses of SORTS training readiness and underway time. That study found that the probability of deploying with C1 status in training increased with more underway time. The analysis was limited, however, by a relatively small sample size and by the lack of controls for variables other than underway time that could simultaneously affect readiness.

This research memorandum analyzes the probability that surface combatants, specifically frigates and destroyers, begin deployment fully combat ready in training, that is, the combatants have a C1 rating. In particular, the analysis examined the relationships between deploying fully combat ready in training and various measures of the ship's OPTEMPO, enlisted crew turnover, and the material condition in the months before deployment. Appropriate control variables for ship type, year of deployment, and fleet were also included in the models.

1. Reference [2] contains a more complete discussion of this point.

DATA FOR THE ANALYSIS

SAMPLE SELECTION

To minimize variation in readiness due to ship class, the analysis focused on destroyers and frigates.[1] For frigates and destroyers deploying in the March 1981 to June 1988 time period, three, increasingly inclusive, groups of deployed destroyers and frigates were identified. Because a major overhaul is both an intensive and extensive event, the first deployment after a major overhaul should provide the sharpest evidence of the effects of OPTEMPO, crew turnover, and ship material condition on the probability of deploying C1 in training. The first two groups, defined below, include only the first deployment after a major overhaul:

- *Group one*: Frigates and destroyers whose C5 status does not extend more than two months after a major overhaul event and who then deploy without an intervening overall SORTS status of not readily available (C5 overall). There were 88 such deployments in the data set.

- *Group two*: Frigates and destroyers who deploy 6 to 23 months after a major overhaul event. Such a deployment should include all ships deploying in a normal training evolution after a major overhaul event. In all, there were 192 such deployments in the data set.

- *Group three*: Frigates and destroyers who deploy 6 to 95 months after a major overhaul event. Such deployments would include ships deploying in a normal training evolution after a major overhaul event, as well as ships deploying without having had a major overhaul. In all, there were 399 such deployments in the time period analyzed.

Whether a ship deploys C1 in training readiness was related to two alternative measures of OPTEMPO (table 1). The first set of OPTEMPO variables uses steaming hours. Steaming hours were measured as the monthly average of underway steaming hours in the six months before the deployment (AVG_SHU), the monthly average of not-underway steaming hours in the six months before the deployment (AVG_SHN),[2] and the steaming hours underway in the month

1. The research plan was to identify ships that were in the lowest overall readiness status—a unit not readily available for combat—and then to trace that ship until it deployed. SORTS data, formerly called Unit Status and Identity Report (UNITREP), were used to identify ships that were in such status (C5 in overall readiness). After the data set was constructed, however, it was realized that ships in C5 overall readiness status had not necessarily been in a major maintenance event. Thus, the data set was partitioned into three sets (described in the text). The first two sets are composed of ships whose deployment was preceded by a major overhaul event.

2. For ships in groups two and three that were in an availability during the six months before deployment, the average steaming hours were the average since the end of the availability.

before the deployment (SHU1). The second set of OPTEMPO measures was constructed from the underway days the ship spends in the months before deployment. Two variables were constructed: the average fraction of the month the ship was underway in the six months before deployment (AVG_UND) and the fraction of the month the ship was underway in the month before deployment (UND1).

Table 1. Description of variables and data sources

Variable	Description	Data source
DEPLOY_C1	Training readiness was C1 when the ship deployed	SORTS data, formerly called UNITREP
MANREQ	Enlisted manning relative to M+1 manning requirements (see main text for more complete description)	DMDC UIC manning tapes and billet e data
PNEW3	Percent of enlisted crew new to the ship in the three months before deployment	DMDC UIC manning data
NEW_ENG6	Percent of enlisted crew in engineering ratings new to the ship in the six months before deployment	DMDC UIC manning data
PAC	Value of 1 if ship in Pacific Fleet	Ship Employment History File
YEAR	Year deployed	Ship Employment History File
C3/C4 CASDAYs	Total of C3 or C4 CASREP days in the six months before deployment. For example, two outstanding C3 or C4 CASREPs for an entire 30-day month are defined to be 60 CASDAYs.	CASREP data
MSO	Months since overhaul for ships except FFG-7s. Because FFG-7s do not have overhauls, MSO is defin 1 as months since C5 status.	Ship Employment History File and SORTS data
SUBSEQUENT_DEPLOY	Control variable with value of 1 for a deployment that is not the first since an overhaul	Constructed from Ship Employment History File

Table 1. (Continued)

Variable	Description	Data source
AVG_SHU	Monthly average of steaming hours underway for the six months before deployment	Ship Fuel and Hours data
AVG_SHN	Monthly average of steaming hours not underway in the six months before deployment	Ship Fuel and Hours data
SHU1	Steaming hours underway in the month before deployment	Ship Fuel and Hours data
AVG_UND	Average proportion of days underway in the six months before deployment	Ship Employment History File
UND1	Proportion of days underway in the month before deployment	Ship Employment History File

Two variables on enlisted manning were used in the analysis. The first, PNEW3, is the percent of the ship's enlisted crew who are new to the ship in the three months before the deployment. The second, MANREQ, is a measure of the ship's enlisted manning relative to requirements. MANREQ, however, is not simply a count of enlisted manning relative to the requirements. Because higher paygrade personnel are presumably more productive than those in lower paygrades, a variable that reflects the mix of paygrades was developed to better capture the quality of the manning.

In the absence of established measures of the relative productivities of personnel in different paygrades, it was decided to use basic pay to weight the relative productivities. If P_i is the average basic pay for the ith paygrade, N_i is the number of personnel in that paygrade, and R_i is the number of M+1 personnel required in the paygrade, the manning variable, MANREQ, is defined as follows:

$$\text{MANREQ} = \frac{\sum_{i=1}^{9} P_i N_i}{\sum_{i=1}^{9} P_i R_i} \quad .$$

Thus, MANREQ is the ratio of the sum of the basic pay of enlisted personnel currently on board divided by basic pay of personnel required at *M*+1.[1]

Ship material condition before the deployment was measured by the total number of C3 or C4 CASREP days in the six months before the deployment (C3/C4 CASDAYs). For groups one and two—the deployment directly after an overhaul—models include a variable for the number of months since the overhaul (MSO). This variable was included to capture the fact that more time between the end of overhaul and the beginning of the deployment may increase the probability that the ship will complete the training exercises required to deploy C1 in training. For group three, which includes second and third deployments after an overhaul, the models control for whether this is a first deployment after an overhaul or, instead, a subsequent deployment (SUBSEQUENT_DEPLOY). Finally, the analysis included control variables for the year of deployment and the fleet.

Table 2 provides variable means and, when appropriate, standard deviations for each of the three ship groups. Ships that deploy after a maintenance availability without an intervening C5 period (group one by the taxonomy here) are the least likely to deploy C1 in training.

RELATIONSHIP BETWEEN DEPLOYING C1 IN TRAINING AND OPTEMPO, CREW TURNOVER, AND SHIP MATERIAL CONDITION

The analysis first compares the univariate relationships, supported by subsequent multivariate analysis, of OPTEMPO, crew turnover, and ship material condition for ships that deployed C1 in training and ships that did not. This is followed by an examination of the empirical models that were estimated to examine the relationship between the probability that surface combatants will deploy C1 in training and these variables.

Figures 1 through 3 show median steaming hours (underway) in the six months before deployment for each ship group. Separate tabulations are made for ships that deployed C1 in training and ships that did not deploy C1 in training.[2] Each of the three ship groups exhibits a clear difference in steaming hours for ships that deploy C1 in training and those that do not. First, ships that deploy C1 in training have more total hours of underway steaming time in the six months before deployment than those that do not. (In the figures, the combined height of the black stovepipes is higher than the combined height of the white stovepipes.) The largest monthly

1. The enlisted manning data were obtained from a quarterly UIC manning file constructed by the Defense Manpower Data Center for CNA, whereas the *M*+1 requirements data come from the billet file. CNA does not have accurate billet file data before 1983. Thus, *M*+1 requirements (necessary for the denominator of MANREQ) for the years 1981 and 1982 have been assumed to be identical to those for 1983.

2. Information on deployments (which was necessary to determine the relevant ships for the analysis) come from the ship employment history file. A ship is considered deployed when a deployed record is found on the ship employment history or when it operates in ocean areas P4 (WestPac), P6 (Indian Ocean), A6 (Mediterranean), or A7 (Persian Gulf). A deployment begins when a ship leaves its homeport (or an overhaul) and ends when the ship returns to its homeport (or enters overhaul).

Table 2. Variable means for the three samples (standard deviations are in parentheses)

Variables	Specification (1)	(2)	(3)
DEPLOY_C1	.71	.82	.85
Ship control variables			
DD963	.21	.18	.19
DDG2	.26	.14	.16
DDG37	.08	.07	.08
DDG993	–	.02	.03
FF1040	.12	.05	.05
FF1052	.28	.20	.31
FFG1	.03	.03	.03
FFG7	.02	.31	.15
PAC	.42	.39	.45
MANREQ	82.72	87.40	86.43
	(6.50)	(7.96)	(7.20)
PNEW3	11.83	10.66	10.65
	(4.48)	(4.09)	(3.82)
NEW_ENG6	25.99	23.90	20.89
	(17.63)	(16.45)	(6.60)
MSO	11.47	12.02	28.32
	(3.60)	(3.96)	(18.50)
C3/C4 CASDAYs[a]	2.52	1.91	1.59
	(2.39)	(2.13)	(1.74)
AVG_SHU[a]	2.18	2.12	2.13
	(.57)	(.60)	(.67)
AVG_SHN[a]	1.43	1.54	1.34
	(.77)	(.94)	(.85)
SHU1[a]	2.14	1.94	1.77
	(1.56)	(1.58)	(1.54)
AVG_UND	.38	.36	.35
	(.10)	(.10)	(.10)
UND1	.31	.28	.27
	(.21)	(.22)	(.22)
SUBSEQUENT_DEPLOY	–	–	.52
Number of deployments	88	192	401

a. In hundreds of hours.

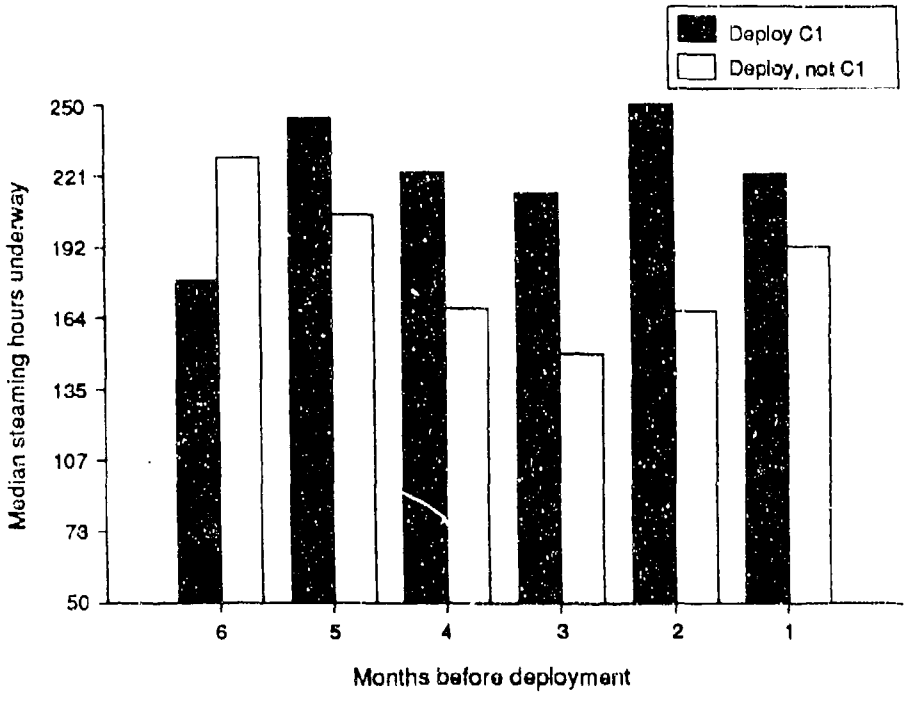

Figure 1. Median underway steaming hours in the six months before deployment: ship group one

differences are usually in the three- to four-month period before deployment when those ships that will not deploy C1 in training appear to steam significantly fewer hours. Finally, ships that do not deploy C1 in training appear to try to "catch up" by maintaining relatively high underway steaming hours in the last month before deployment; ships that do deploy C1 do not.

Figure 4 illustrates another difference among ships that deploy C1 in training and those that do not—namely, the fraction of the enlisted crew that was new to the ship's company in the three months before deployment (PNEW3). The top panel of figure 4 reports median turnover rates; the bottom panel examines the entire distribution of personnel turnover for ships that deploy C1 in training and those that do not. The figures in the bottom panel are called "box diagrams" and show, for each group and training deployment status, the 10th, the 25th, the median (50th), the 75th, and the 90th percentile value for the variable PNEW3.

For the first ship groups, the median value of PNEW3 is 11.0 percent for ships that deploy C1 in training and 12.8 percent for ships that deploy with training readiness less than C1. In fact, the turnover rate for the 75th percentile of ships deploying C1 is 12.8 percent—the same as the median turnover rate for ships in the group not deploying C1 in training. For every group and every measure of the distribution, ships deploying C1 in training had lower values for crew turnover. This is, indeed, a very strong finding.

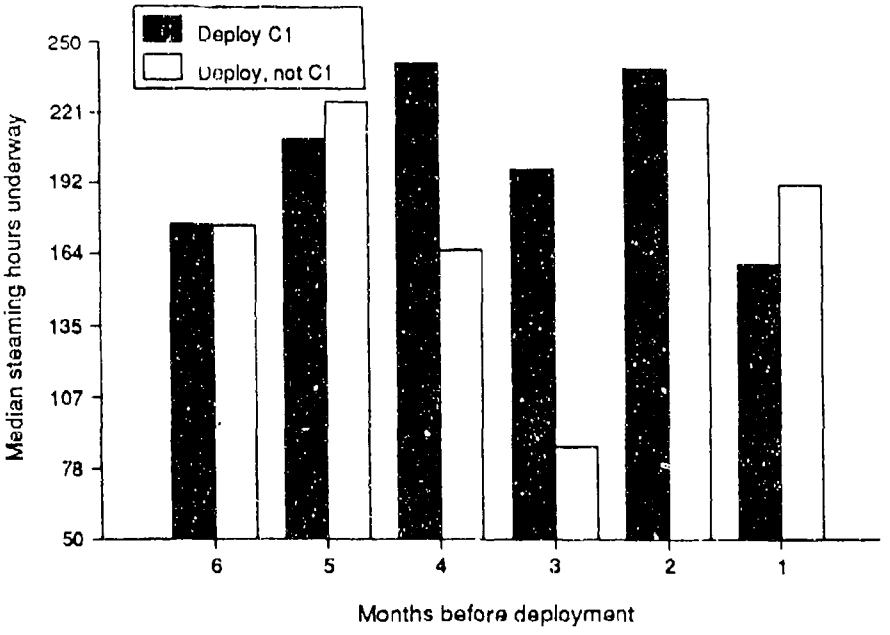

Figure 2. Median underway steaming hours in the six months before deployment: ship group two

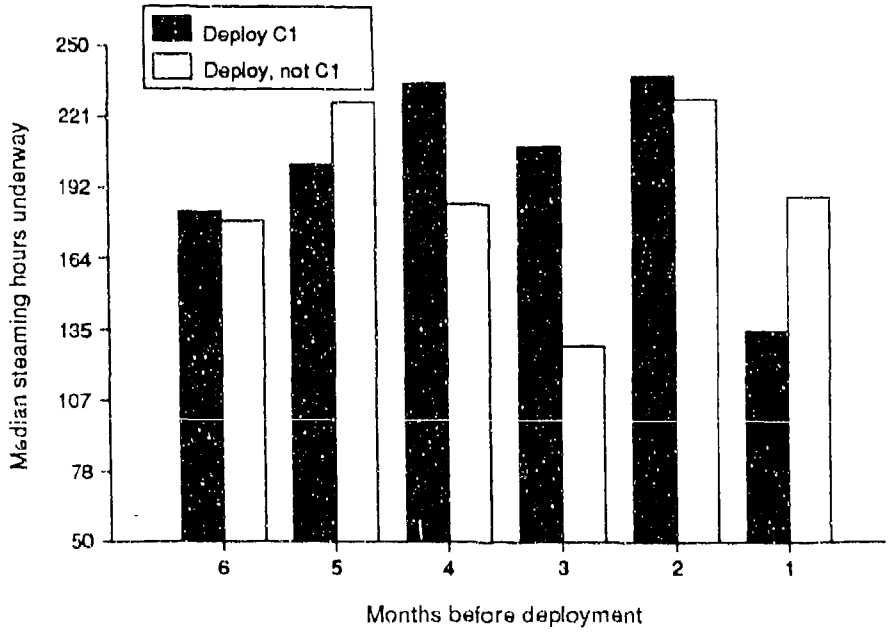

Figure 3. Median underway steaming hours in the six months before deployment: ship group three

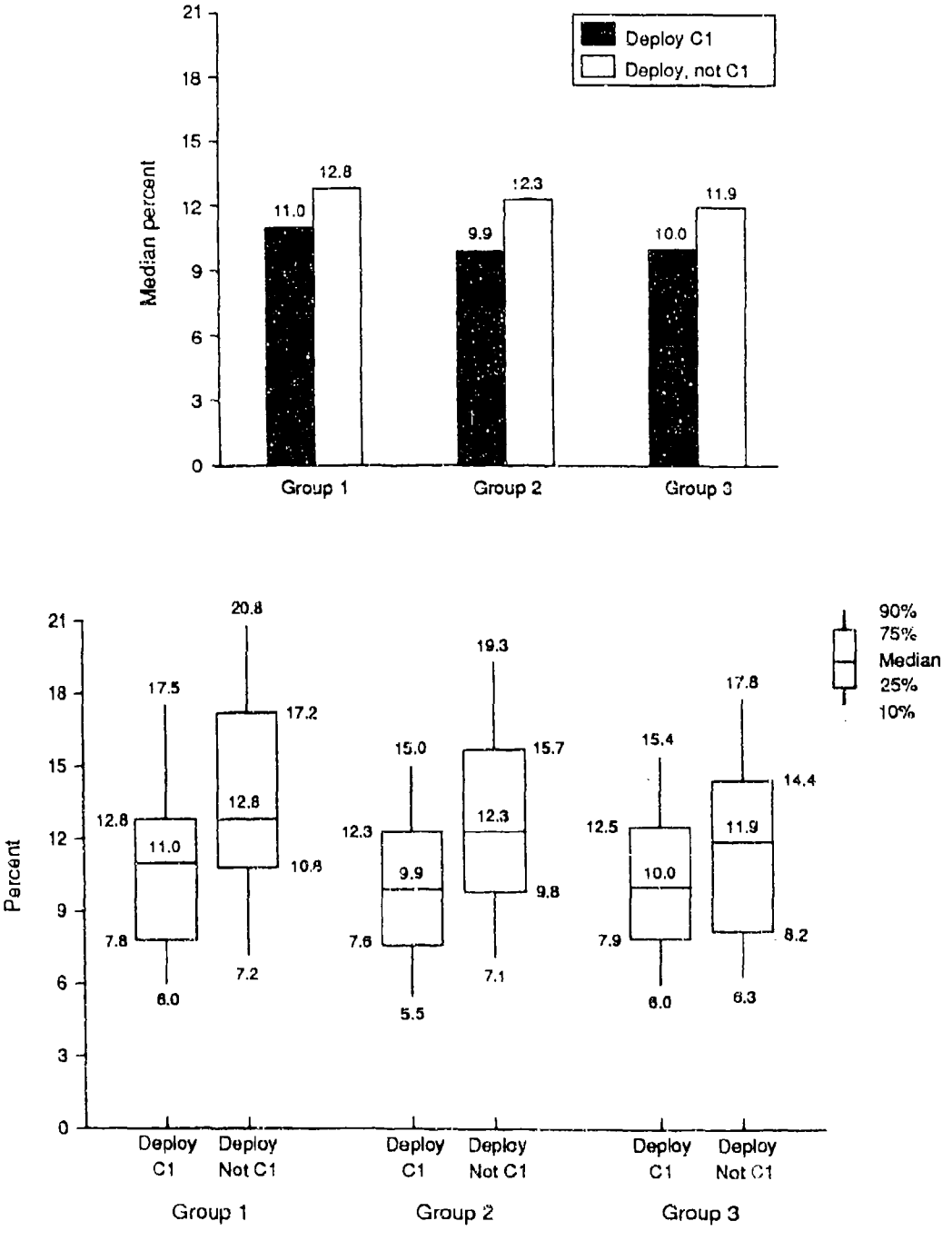

Figure 4. Three-month enlisted crew turnover rates

Personnel in the engineering ratings are perhaps those most important for the successful completion of the exercises required for C1 training status readiness.[1] Figure 5 illustrates these turnover rates (again with the top panel illustrating only the median rate and the bottom panel the full distribution of the turnover rates. Differences in these turnover rates in the quarter before deployment sharply delineate ships that deploy C1 in training from those that do not.

Figure 6 examines the relationship between serious problems with ship material condition in the six months before deployment (C3/C4 CASDAYs) and whether the ship deploys C1 in training. Again, the results are reported first for the median and then for the entire distribution, and, again, the results are very regular. For all three groups, ships that deploy C1 in training are considerably less likely to have been bothered with serious mission-degrading equipment problems in the six months before deployment.

1. The following ratings were designated engineering ratings: MM, EN, MR, BT, [illegible], EM, IC, ET, GS, GSE, GSM, PM, ML, and DC.

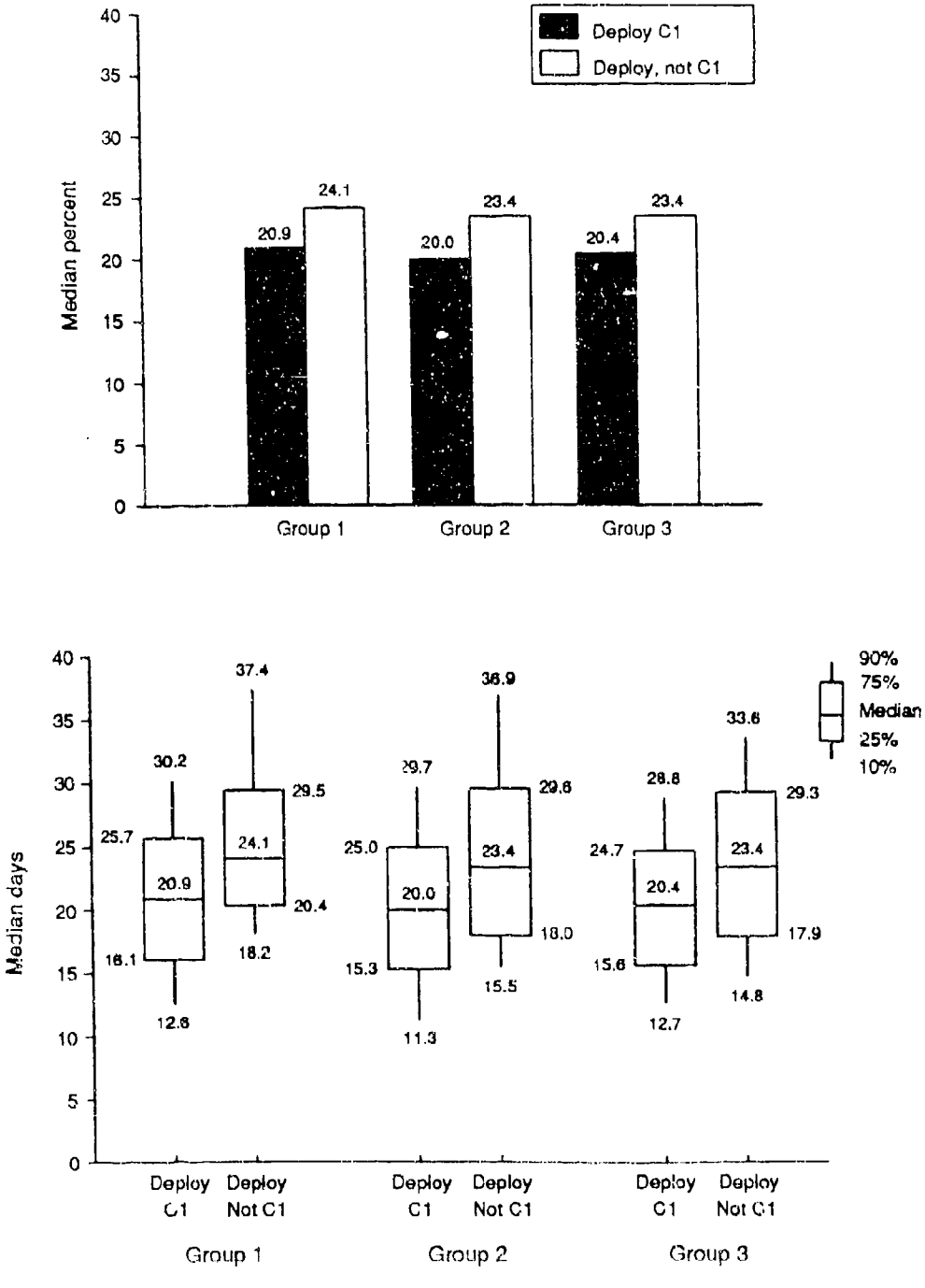

Figure 5. Six-month enlisted crew turnover rate in the engineering ratings

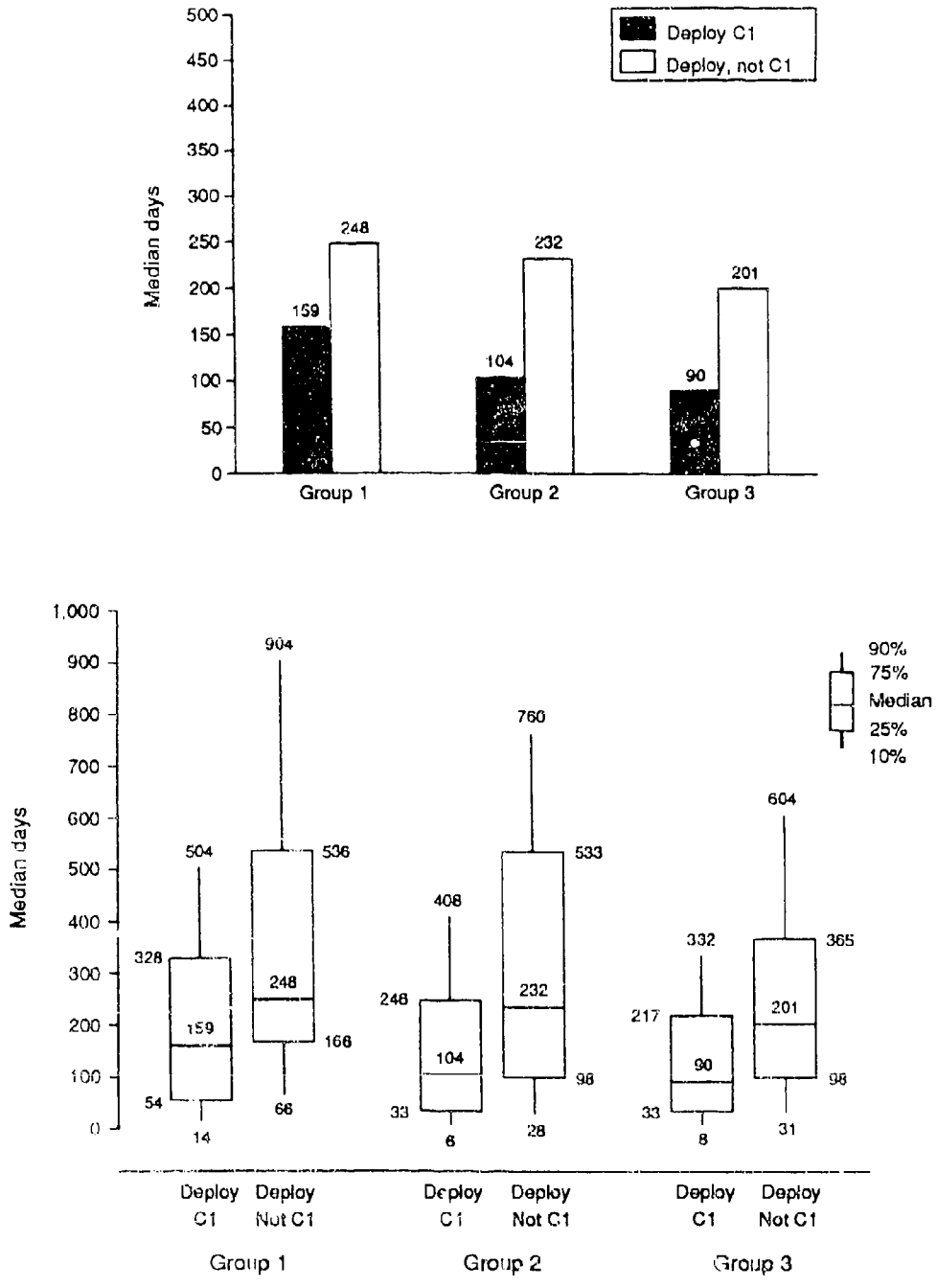

Figure 6. C3/C4 CASDAYs in the six months before deployment

EMPIRICAL ESTIMATION OF THE MODELS

Whether or not a ship deploys C1 in training is an either/or event. As such, it is appropriate to estimate such a model by a nonlinear method that essentially estimates an S-shaped probability curve between the two limit values (1 = deploys C1 in training; 0 = does not deploy C1 in training). Figure 7 illustrates such an S-shaped curve for a hypothetical independent variable. One appropriate statistical model is the logit. The appendix details the technical properties of the logit function as well as the logit coefficients that were estimated for these models.

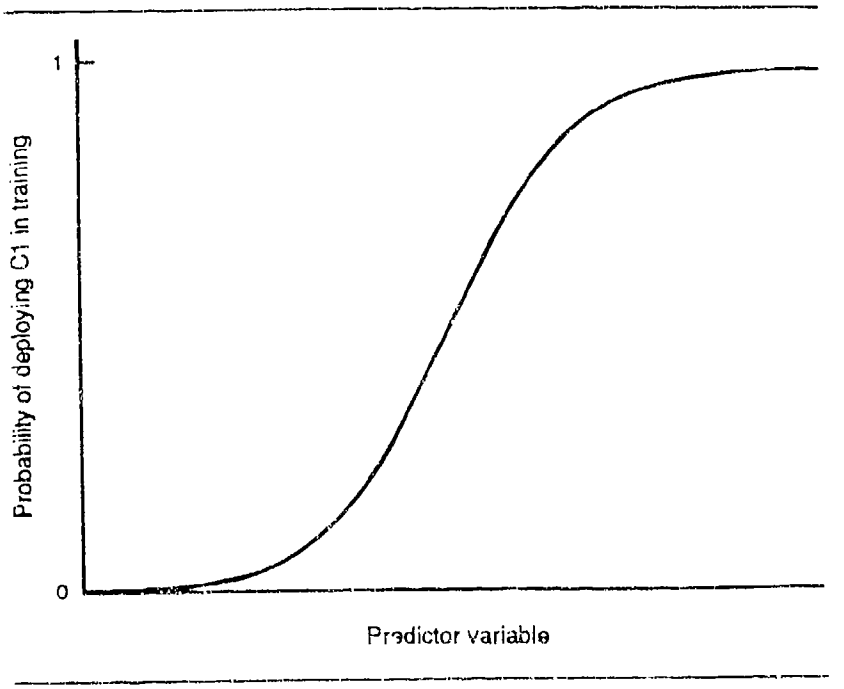

Figure 7. Example of a logit curve

The general form of the estimated logit models was

DEPLOY_C1 = f [personnel(PNEW3, MANREQ); ship material condition (C3/C4 CASDAYs); OPTEMPO; and fleet (PAC)] .

Sets of OPTEMPO measures were defined two ways: (1) average monthly steaming hours underway in the six months before deployment and (2) the percent of days underway for the same time period. For each set of OPTEMPO measures, the models were estimated separately with and without controls for the year of the deployment. One set of tables for each ship group

contains these four specifications in the context of a model that also controls for ship class (see tables A-1, A-3, and A-5 of the appendix).[1]

Ship-class controls are appropriate because of unmeasured differences across the different classes of frigates and destroyers.[2] Still, some of the variables have almost all of their variation across ship classes. For example, 70 percent of the variation in MANREQ is across ship class (rather than variation within class), because some classes are manned better relative to requirements than others. Thus, in an attempt to capture variation that is substantially ship-class-specific, the four models for each of the three ship groups were also estimated without controls for ship class (see tables A-2, A-4, and A-6 in the appendix). The results for the effect of OPTEMPO are unchanged by the exclusion of ship-class variables. As expected, personnel effects changed somewhat.

FINDINGS

In general, the findings indicate that a number of resources affect the probability of deploying C1, particularly for the first deployment after an overhaul. The effects of most variables are somewhat less for subsequent deployments. This result is not surprising because an overhaul creates a major long-term disruption in the normal activities of a surface combatant. When a ship comes out of an overhaul, the crew must start almost from scratch, first checking out the ship and then initiating training. Thus, the effects of crew turnover and OPTEMPO before first deployment are more pronounced because the training readiness of the crew is at a lower level.[3]

Personnel

Enlisted crew turnover in the quarter before deployment had a significant effect on the probability of deploying C1 in training for ships coming out of overhaul. For these deployments, other things equal, crew turbulence before deployment hurt a ship's chances of deploying C1 in training (see tables A-1 and A-3 of the appendix). When the second or third deployment after an overhaul is included in the sample, however, crew turnover before deployment remains negatively related to the probability of deploying C1 in training, but the variable loses its statistical significance (see table A-5).

The effects of better manning relative to requirements are found to be essentially zero in the models with controls for ship class (see tables A-1, A-3, and A-5 of the appendix). As discussed earlier, however, most of the variation in MANREQ is variation across ship classes. Thus, in the

1. A control variable for ship class essentially allows each ship class to have its own intercept.
2. It would be preferable to estimate the model separately by class. Unfortunately, no class contained sufficient numbers of observations to estimate a reliable model.
3. Another explanation may be that the factors that influence the probability of deploying C1 are systematically different for ships coming out of an overhaul than for ships that deploy after an interdeployment training cycle.

models that control for ship class, it is possible that the positive effects of better manning are being captured by the ship-class control variables. In any case, when the models are estimated without controls for ship class, MANREQ is always positively and significantly related to the probability that the ship deploys C1 in training (see tables A-2, A-4, and A-6). Again, sufficient numbers of deployment observations for one ship class are needed to really identify the relationships.

Ship Material Condition

One consistently strong finding was that poorer material condition, as measured by the number of C3/C4 CASREP days, was related to a lower probability of ships deploying with C1 status in training. The relationship, however, is complex: ships with serious material condition problems may find these problems interfering with training demands. Similarly, they may find they cannot steam because of equipment failures. The result reported is conditional on underway time, however. The model measures the additional effect of material condition on the probability of deploying C1 in training, independent of any reduction in underway time that may result from problems in material condition.

OPTEMPO

OPTEMPO was consistently related to the probability of deploying C1. Results were similar regardless of which of the two OPTEMPO measures was used--average monthly steaming hours underway in the six months before deployment or the percent of days underway in the same period. In both cases, results were statistically significant for the first two groups of ships studied. The estimated coefficients were positive, but generally not statistically significant at conventional significance levels for observations that include subsequent deployments.

Steaming hours not underway were negatively related to the probability of deploying C1 in training. Additional steaming hours underway or fraction of time underway in the month before deployment, the catch-up pattern seen in figures 1 through 3, was negatively related to C1 deployments, although the estimated effects did not usually achieve conventional levels of statistical significance. The direction of causality for this variable is open to interpretation.

Table 3 illustrates the magnitude of the estimated historical effects for ships in their first deployment after an overhaul. All effects or changes in the independent variables are calculated at the mean of the data, statistically holding the other variables constant. It should be remembered, however, that even though these partial derivatives can be calculated from the estimated logit coefficients, the calculation is a mathematical one that does not consider the historical interactions among factors. Ship material condition, for example, is not independent of OPTEMPO or crew turnover.

Table 3. Estimated historical effect, at the mean of the data, of changes in independent variables on the likelihood of deploying C1 in training

Change in independent variable	Effect on likelihood of deploying C1 in training
Decrease NEW_ENG6 by 2 percentage points	.83 to .86 percentage point increase
Decrease C3/C4 CASDAYs in six months before deployment by 25 CASDAYs	.71 to .83 percentage point increase
OPTEMPO	
Increase AVG6_SHU by ten hours	.77 to .79 percentage point increase
Increase AVG6_UND by 1 percent	.86 to .91 percentage point increase

NOTE: The percentages were calculated using coefficient estimates in table A-3 of the appendix. The average likelihood of deploying C1 was 82 percent for this sample. Thus, a 2 percentage point decrease in NEW_ENG6 was estimated to increase the average likelihood to 82.3.

SUMMARY

Most surface combatants deploy C1 in training. Indeed, the Navy devotes substantial effort to ensure that ships scheduled to deploy can perform the exercises required for C1 status in training. Still, some ships do deploy without full training readiness. This analysis examined the factors associated with deploying C1 in training. The following four factors were regularly associated with a higher probability of deploying with a readiness status of C1 in training:

- OPTEMPO, indicated by high levels of steaming hours underway or by the fraction of days in the month underway, is positively related to deploying C1 in training. Its impact is considerably more important, however, for the first deployment after an overhaul.
  - — Ships that did not deploy C1 in training had lower levels of average monthly steaming hours underway, particularly in the third and fourth months before deployment.
  - — Ships that did not deploy C1 in training appear to try to make up for lower past OPTEMPO with underway steaming hours in the month before deployment. This strategy did not appear to work.
- Lower levels of enlisted engineering crew turnover before deployment were positively related to the probability of deploying C1 in training. Again, this effect was considerably stronger for the first deployment after an overhaul.
- Better manning relative to requirements may be important to deploying C1 in training. Most of the historical relationships, however, are related to differences among ship classes rather than within classes. Until sufficient numbers of deployments for a single ship class are available, these results need to be interpreted cautiously.
- Better material condition was positively related to the probability of deploying C1 in training.
  - — More C3/C4 CASDAYs in the six months before deployment decreased the probability of deploying C1 in training.

REFERENCES

[1] Evaluation Research Corporation International, *Study of Training Resources to Battle Group Readiness*, May 88

[2] CNA Research Memorandum 88-208, *Crew Performance in Atlantic Fleet Refresher Training*, by Karen N. Domabyl and Alan J. Marcus, Nov 1988 (27880208)[1]

[3] CNA Research Memorandum 86-123, *OPTEMPO and Ship Readiness*, by Dean A. Fellmann, Alan J. Marcus, and Linda C. Cavaluzzo, Jun 1986 (27860123)

[4] *OPTEMPO and Training Effectiveness*, Proceedings of the NATO Symposium on the Military Value and Cost-Effectiveness of Training, Jan 1985

1. The number in parentheses is a CNA internal control number.

APPENDIX

LOGIT CURVE ESTIMATION

APPENDIX

LOGIT CURVE ESTIMATION

Logit regression analysis estimates the following relationship for individual ships that deploy, or do not deploy, C1 in training:

$$P(deploy\ \text{C1}) = \left(1 + e^{-B'x}\right)^{-1} \quad ,$$

where B' is a row vector of coefficients and x is a column vector of variables.

The partial derivative of the logit function at the mean of the function is as follows:

$$\frac{\partial P}{\partial x_i}(\bar{P})\ (1 - \bar{P})\ B_i \quad ,$$

where i is the ith variable. The following equations illustrate this result:

$$P = \left(1 + e^{-B'x}\right)^{-1}$$

$$1 - P = \left(e^{-B'x}\right)\left(1 + e^{-B'x}\right)^{-1}$$

$$\frac{\partial P}{\partial x_i} = -\left(1 + e^{-B'x}\right)^{-2}\left(-B_i e^{-B'x}\right)$$

$$= \left(1 + e^{-B'x}\right)^{-1} \frac{\left(B_i\right)\left(e^{-B'x}\right)}{\left(1 + e^{-B'x}\right)}$$

$$= P\left(B_i\right)(1 - P)$$

$$= B_i(P)(1 - P) \quad .$$

Tables A-1 through A-6 provide a slope-adjustment factor that, if multiplied by the logit coefficient, will provide the partial derivative for the variable at the mean of the data. This is often identified as the slope of the conditional mean function.

Table A-1. Logit coefficient estimates for probability of deploying C1 in training: ship group one with controls for ship class

	Specification			
Variable	(1)	(2)	(3)	(4)
NEW_ENG6	-.081	-.071	-.086	-.074
	(-1.69)	(-1.45)	(-1.88)	(-1.63)
MANREQ	.004	.118	.007	.124
	(.11)	(1.24)	(-.17)	(1.30)
PAC	-.175	-.129	.289	.399
	(-.23)	(-.17)	(.41)	(.54)
YEAR	–	-.137	–	-.148
		(-1.07)		(-1.09)
C3/C4 CASDAYs	-.196	-.236	- 199	-.234
	(-1.36)	(-1.60)	(-1.39)	(-1.62)
MSO	.096	.136	.124	.184
	(.86)	(1.17)	(.91)	(1.27)
AVG_SHU	1.433	2.490	–	–
	(1.87)	(1.95)		
AVG_SHN	-1.148	-.925	-1.209	-1.071
	(-1.88)	(-1.52)	(-1.89)	(-1.71)
SHU1	-.239	-.238	–	–
	(-.86)	(-.84)		
AVG_UND	–	–	5.589	6.916
			(1.20)	(1.42)
UND1	–	–	-1.843	-1.841
			(-.89)	(-.86)
Chi-square	43.7	45.6	41.6	43.7
Ship-class controls	Yes	Yes	Yes	Yes

NOTE: The slope-adjustment factor (for the slope of the conditional mean function) is 0.206.

Table A-2. Logit coefficient estimates for probability of deploying C1 in training: ship group one, no controls for ship class

	Specification			
Variable	(1)	(2)	(3)	(4)
NEW_ENG6	-.021 (-1.23)	-.025 (-1.26)	-.021 (-1.27)	-.021 (-1.27)
MANHEQ	.136 (2.37)	.155 (2.04)	.159 (2.84)	.186 (2.47)
PAC	-.244 (-.35)	-.352 (-.47)	.184 (.27)	.044 (.06)
YEAR	–	-.117 (-.39)	–	-.167 (-.57)
C3/C4 CASDAYs	-.238 (-1.95)	-.260 (-1.91)	-.252 (-2.10)	-.283 (-2.11)
MSO	.130 (1.21)	.144 (1.29)	.157 (1.42)	.177 (1.56)
AVG_SHU	1.430 (2.19)	1.426 (2.17)	–	–
AVG_SHN	-.490 (-1.15)	-.523 (-1.20)	-.621 (-1.43)	-.670 (-1.51)
SHU1	-.099 (-.43)	-.124 (-.51)	–	–
AVG_UND	–	–	5.955 (1.62)	6.012 (1.62)
UND1	–	–	-.634 (-.39)	-.808 (-.43)
Chi-square	32.6	32.8	29.8	30.1
Ship-class controls	No	No	No	No

NOTE: The slope-adjustment factor (for the slope of the conditional mean function) is 0.206.

Table A-3. Logit coefficient estimates for probability of deploying C1 in training: ship group two with controls for ship class

	Specification			
Variable	(1)	(2)	(3)	(4)
NEW_ENG6	-.029 (-2.09)	-.028 (-2.04)	-.029 (-2.18)	-.028 (-2.09)
MANREQ	.027 (.71)	.036 (.59)	.016 (.45)	.038 (.63)
PAC	.393 (.69)	.393 (.69)	.570 (.97)	.584 (.99)
YEAR	–	–	-.012 (-.19)	-.275 (-.45)
C3/C4 CASDAYs	-.191 (-1.85)	-.194 (-1.86)	-.214 (-2.04)	-.223 (-2.09)
MSO	-.022 (-.28)	-.020 (-.26)	.016 (.20)	.023 (.27)
AVG_SHU	.522 (1.12)	.534 (1.14)	–	–
AVG_SHN	-.320 (-1.07)	-.308 (-1.01)	-.423 (-1.43)	-.411 (-1.34)
SHU1	-.195 (-1.16)	-.201 (-1.17)	–	–
AVG_UND	–	–	5.036 (1.78)	5.336 (1.83)
UND1	–	–	-1.922 (-1.53)	-2.031 (-1.58)
Chi-square	59.1	59.2	61.6	61.8
Ship-class controls	Yes	Yes	Yes	Yes

NOTE: The slope-adjustment factor (for the slope of the conditional mean function) is 0.148.

Table A-4. Logit coefficient estimates for probability of deploying C1 in training: ship group two, no controls for ship class

	Specification			
Variable	(1)	(2)	(3)	(4)
NEW_ENG6	-.018	-.007	-.017	-.005
	(-1.67)	(-.63)	(-1.58)	(-.41)
MANREQ	.107	.078	.130	.100
	(3.36)	(2.41)	(3.79)	(2.88)
PAC	.325	.659	.512	.912
	(.60)	(1.17)	(.94)	(1.58)
YEAR	–	.344	–	.375
		(2.27)		(2.43)
C3/C4 CASDAYs	-.232	-.146	-.265	-.175
	(-2.65)	(-1.58)	(-2.96)	(-1.87)
MSO	.052	.063	.080	.091
	(.86)	(1.06)	(1.26)	(1.48)
AVG_SHU	.665	.739	–	–
	(1.61)	(1.70)		
AVG_SHN	.094	.188	-.059	-.017
	(.33)	(.65)	(-.22)	(-.06)
SHU1	-.150	-.074	–	–
	(-.97)	(-.47)		
AVG_UND	–	–	6.274	7.240
			(2.44)	(2.66)
UND1	–	–	-1.502	-1.053
			(-1.35)	(-.93)
Chi- quare	41.5	47.1	51.9	51.8
Ship-class controls	No	No	No	No

NOTE: The slope-adjustment factor (for the slope of the conditional mean function) is 0.148.

Table A-5. Logit coefficient estimates for probability of deploying C1 in training: ship group three with controls for ship class

	Specification			
Variable	(1)	(2)	(3)	(4)
NEW_ENG6	-.029	-.011	-.027	-.009
	(-1.16)	(-.41)	(-1.08)	(-.35)
MANREQ	.056	.000	.057	.000
	(1.43)	(.00)	(1.45)	(.01)
PAC	.793	1.112	.786	1.100
	(2.01)	(2.66)	(2.00)	(2.65)
YEAR	–	.404	–	.408
		(3.58)		(3.62)
C3/C4 CASDAYs	-.331	-.199	-.348	-.218
	(-3.38)	(-1.98)	(-3.51)	(-2.15)
SUBSEQUENT_EPLOY	.196	.137	.255	.186
	(.52)	(.35)	(.67)	(.47)
AVG_SHU	.205	.297	–	–
	(.70)	(.91)		
AVG_SHN	-.378	-.363	-.444	-.460
	(-1.62)	(-1.45)	(-1.85)	(-1.81)
SHU1	-.148	-.108	–	–
	(-1.29)	(-.91)		
AVG_UND	–	–	2.305	2.825
			(1.26)	(1.45)
UND1	–	–	-1.335	-1.191
			(-1.64)	(-1.41)
Chi-square	69.6	84.2	71.3	86.3
Ship-class controls	Yes	Yes	Yes	Yes

NOTE: The slope-adjustment factor (for the slope of the conditional mean function) is 0.128.

Table A-6. Logit coefficient estimates for probability of deploying C1 in training: ship group three, no controls for ship class

	Specification			
Variable	(1)	(2)	(3)	(4)
NEW_ENG6	-.040 (-1.62)	-.023 (-.91)	-.039 (-1.58)	-.022 (-.89)
MANREQ	.095 (3.49)	.062 (2.26)	.099 (3.60)	.067 (2.40)
PAC	.783 (2.01)	1.133 (2.77)	.770 (1.99)	1.110 (2.73)
YEAR	–	.354 (3.43)	–	.351 (3.44)
C3/C4 CASDAYs	-.317 (-3.55)	-.216 (-2.39)	-.332 (-3.69)	-.238 (-2.63)
SUBSEQUENT_EPLOY	.074 (.21)	-.003 (-.01)	.108 (.31)	.026 (.07)
AVG_SHU	–	–	–	–
AVG_SHN	-.061 (-.29)	.051 (.23)	-.110 (-.51)	-.017 (-.08)
SHU1	-.156 (-1.41)	-.116 (-1.01)	–	–
AVG_UND	–	–	1.883 (1.10)	2.219 (1.23)
UND1	–	–	-1.373 (-1.75)	-1.241 (-1.54)
Chi-square	58.4	71.3	59.8	72.8
Ship-class controls	No	No	No	No

NOTE: The slope-adjustment factor (for the slope of the conditional mean function) is 0.128.